(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 522 884 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.11.2012 Bulletin 2012/46

(51) Int Cl.:
F16H 61/32 *(2006.01)*

(21) Application number: **12167227.3**

(22) Date of filing: **09.05.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **09.05.2011 GB 201107680**

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(54) Actuation apparatus and method

(57) A force regulated actuation apparatus (3) for a vehicle manual transmission (1) comprises a gearshift input member (5) or gearstick, an actuator assembly (13) for communicating input force from the gearstick to a gear selector device (11a, 11b, 11c); drive means (23) arranged to load the manual gearshift mechanism; and control means (25) for the drive means (23), said control means controlling the output of the drive means to provide a consistent input force to operate the gearstick (5) during gear selection. The drive means (23) may be a linear motor. The vehicle user may be allowed to select from alternative gearshift force profiles (Fig. 6). Force may be applied by the drive means (23) to assist or resist gearchanges, depending on the comparison between force required and force desired. A method for selecting a gear in a manual transmission is also disclosed.

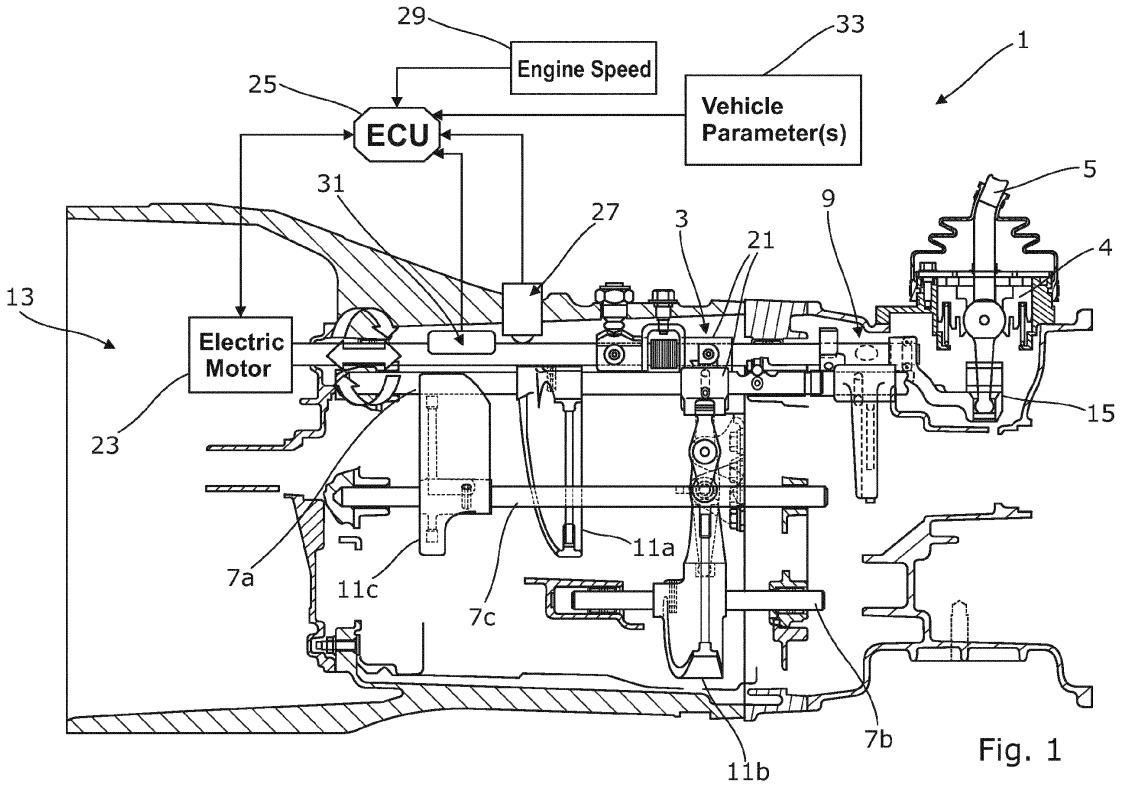

Fig. 1

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Description

[0001] The present invention relates to actuation apparatus for a manual transmission, in particular, but not exclusively, for a manual transmission used in a vehicle. The invention also relates to a method for selecting a gear in a manual transmission.

[0002] In some vehicles having a manual transmission, the gear shift experienced by the driver is unattractive. The amount of effort required by the user to make the gear selection, for at least some gearshifts, makes the shift "feel" unpleasant. The amount of force required to select a gear is determined by the gear being selected and the vehicle operating conditions, such as the vehicle speed. Thus when selecting a gear, the "feel" of the shift can vary noticeably, with some shifts having a less attractive feel than other types of shift.

[0003] The trend of replacing larger vehicle engines with smaller turbo-charged engines with larger torque outputs encourages use of smaller gear boxes with larger inertial clutches. Typically, gear box synchronising capacity has to be increased, while reducing the component size. This often negatively affects the feel of the shift for the driver.

[0004] Accordingly, the invention seeks to mitigate at least one of the afore-mentioned problems.

[0005] According to one aspect of the invention, there is provided an actuation apparatus for a manual transmission, said apparatus including a manual gearshift mechanism having a manually operable input member, such as a shift lever, arranged to enable a user to make gear selections; and an actuator assembly for communicating an input force applied to the input member to a gear selector device; drive means arranged to load the manual gearshift mechanism; and control means, such as an electronic control means, for controlling operation of the drive means, said control means being arranged to control the output of the drive means to control the input force required to operate the input member when a user selects a gear; wherein the control means is arranged to operate the drive means to provide at least one of power assisted movement to the input member and powered resistance to movement of the input member, according to a control algorithm; **characterized in that** the control means is arranged to control the drive means such that the input force required to operate the input member is substantially the same for each gearshift.

[0006] The invention controls the force required to operate the input member, and thereby controls the "feel" of the gearshift that the user experiences through the input member. Thus the "feel" of the gearshift is isolated, to some extent, from the operating conditions of the vehicle.

[0007] As the control means is arranged to control the output of the drive means such that the input force required to operate the input member is substantially the same for each gearshift, the user has to apply substantially the same force to the shift lever for any gearshift, whether selecting low, high or reverse gears. This provides a substantially consistent shift experience for the user regardless of the gear that is selected.

[0008] The gear selector device is mounted between a first gear element and a second gear element, and is movable into and out of engagement with the first and second gear elements according to the operation of the input member. The first and second gear elements are rotatably mounted on a shaft. The arrangement is such that when the selector device engages the gear element, the gear element is locked for rotation with the shaft. When the gear element is not selected, the gear element rotates relative to the shaft. Typically the gear selector device includes a shift collar, for example a synchromesh shift collar.

[0009] The actuator assembly provides a mechanical linkage between the input member and the gear selector device; and therefore provides a load path therebetween.

[0010] The power assisted movement and/or the powered resistance to movement of the input member can be provided to the input member directly; or indirectly via the actuator assembly. The control means adjusts the output of the drive means in response to the user operating the input member.

[0011] Advantageously, the apparatus can include sensing means for sensing at least one of the following parameters: output of the drive means; axial position of part of the manual gearshift device; rotational orientation of part of the manual gearshift device; the force applied to the actuator assembly and/or the input member; temperature; vehicle speed; and the current gear selected; and the control means is arranged to control operation of the drive means according to data received from the sensing means. Furthermore, the control means can be arranged to estimate the next gear to be selected according to inputs received from the sensing means.

[0012] Advantageously, the actuator assembly includes an actuator member; and the sensing means is arranged to sense the axial position and rotational orientation of the actuator member.

[0013] Advantageously, the control means can be arranged to determine the force applied to the input member during a shift; and the control means is also arranged to determine a target force for the user to apply to the input member. The control means may be arranged to calculate the load to be applied to the input member in order to reach the target force. The control means may be arranged to control the output of the drive means to reach the target force. The drive means may be arranged to load the actuator assembly, and the load may be communicated to the input member via the actuator assembly. Thus the control means determines the load to be applied to the actuator assembly, and the direction of the load, in order to reach the target force; and controls the drive means accordingly. Advantageously, the control means is arranged to determine when the target force is reached, for example from the output of the sensing means.

[0014] Advantageously, the actuator assembly can include at least one actuator member having a longitudinal axis, with the drive means arranged to load the actuator member to move in at least one axial direction.

[0015] Advantageously, the actuator assembly can include at least one shift rod having a shift fork mounted thereon, wherein the shift rod is operably connected to the input member and is arranged to communicate load between the input member and the gear selector device via the shift fork. Advantageously, the actuator assembly can include a plurality of shift rods. Typically, a shift rod is provided for each pair of gears.

[0016] Advantageously, the actuator assembly can include a striking rod that is operably connected to the input member and is arranged to communicate load between the input member and the or each shift rod and/or the or each shift fork via a linkage. Thus the striking rod is an actuator member that acts as an extension of the input member to actuate gear selections. The striking rod is arranged for limited axial movement in response to forward and reverse movement of the input member. The striking rod moves axially in response to the input member selecting a gear. The striking rod is arranged for limited rotational movement in response to sideways movement of the input member. The striking rod rotates about its longitudinal axis in response to movement of the input member along a neutral line across the gearshift pattern. The linkage is arranged to selectively drivingly engage the shift rods and/or shift forks according to the rotational orientation of the striking rod. When a shift rod and/or shift fork is drivingly engaged by the linkage, load can be transmitted between an associated gear selector device and the input member.

[0017] Advantageously, the drive means can be positioned to drive at least one of the striking rod, shift rod, shift forks, and linkage. The drive means can also be positioned to drive the input member. The drive means can include at least one motor device. For example, the motor device can comprise a linear motor or a rotary electric motor.

[0018] Advantageously, the control system includes selection means arranged to enable a user to select from a plurality of shift modes. The invention is then able to provide different levels of powered resistance or power assistance, according to a driver's preference. For example, the selection means can be arranged to enable a user to select between shift modes that provide: standard assistance/resistance to movement of the input member, high assistance/resistance to movement of the input member, and low assistance/resistance to movement of the input member. The level of power assistance/resistance for each shift is calculated according to the shift mode selected. Advantageously the selection means includes at least one selection device such as a button, dial or switch. Additionally, or alternatively, the selection means can include a touch sensitive screen that provides a graphical interface with the control means.

[0019] In a preferred embodiment, the drive means is arranged to load the actuator assembly, and the load is communicated to the input member via the actuator assembly. For example, when providing power assistance to the input member, the drive means applies a load to the actuator assembly substantially in the direction of movement of the actuator assembly. When providing resistance to movement of the input member, the drive means applies a load to the actuator assembly in a direction that is substantially opposite to the direction of movement of the actuator assembly.

[0020] Advantageously, the drive means is arranged to drive the actuator member in either axial direction. The direction selected is determined by the control means in accordance with the control algorithm. Advantageously, the actuator member can include a striking rod. Advantageously, the actuator member can include a shift rod.

[0021] Advantageously, the drive means can include a rotatable output member, and the drive means includes means for converting rotational movement of the output member to translational movement of the actuator assembly.

[0022] According to another aspect of the invention, there is provided a method for selecting a gear in a manual transmission, said method including providing actuation apparatus according to any of the above paragraphs, including a manual gearshift mechanism having a manually operable input member for making gear selections and an actuator assembly for communicating an input force applied to the input member to a gear selector device; loading the manual gearshift mechanism using drive means; and adjusting the output of the drive means to control the input force required to operate the input member when a user selects a gear; and including controlling the drive means such that the input force required to operate the input member is substantially the same for each gearshift.

[0023] Advantageously, the method can include estimating the next gear to be selected according to inputs received from sensor means.

[0024] The method can include providing actuation apparatus according to any configuration described herein.

[0025] The method can include determining the force applied to the input member by the user.

[0026] The method can include calculating a target force for the user to apply to the input member.

[0027] The method can include determining at least one vehicle parameter and calculating the target force according to the at least one vehicle parameter. Preferably the method includes determining a plurality of vehicle parameters and calculating the target force according to the plurality of vehicle parameters. The or each vehicle parameter can be obtained, for example by sensing means. The vehicle parameter can be measured directly or can be determined by measuring another parameter, and calculating the vehicle parameter on the basis of the measured parameter and a known relationship between the measured parameter and the desired vehicle parameter.

[0028] The method can include calculating the required increase, or decrease, in force in order to reach the target force.

[0029] The method can include controlling the output of the drive means to reach the target force.

[0030] According to another aspect of the invention, there is provided a transmission including the actuation apparatus according to any configuration described herein, and/or adapted to use a method according to any selection of steps described herein.

[0031] According to another aspect of the invention, there is provided a drivetrain for a vehicle including apparatus according to any configuration described herein, and/or adapted to use a method according to any selection of steps described herein.

[0032] According to another aspect of the invention, there is provided a vehicle including apparatus according to any configuration described herein, and/or adapted to use a method according to any selection of steps described herein.

[0033] An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of apparatus for actuating a manual transmission in accordance with the invention;

Figure 2 is a plan view of part of the manual transmission of Figure 1;

Figure 3 is an isometric view of part of the transmission of Figure 1;

Figure 4 shows an arrangement of slots for controlling the movement of a gear lever;

Figures 5a and 5b show graphs of shift effort vs. gear knob (top of shift lever) displacement for unassisted gear selections;

Figure 5c shows a graph of shift effort vs. gear knob (top of shift lever) displacement for assisted gearshifts; and

Figure 6 shows a graph of shift effort vs. gear knob (top of shift lever) displacement for assisted shifts, for a plurality of different shift profiles.

[0034] Figures 1 to 3 show part of a six-speed manual transmission 1 that includes an apparatus 3 for manually selecting gears. In Figures 1 to 3 the gears and synchromesh selector assemblies have been omitted for clarity.

[0035] The apparatus 3 for manually selecting gears includes a gear lever 5, first, second, third and fourth shift rods 7a-d, a striking rod 9, and first, second, third and fourth shift forks 11a-d. The transmission further includes a drive system 13 for selectively loading the apparatus 3 for manually selecting gears thereby controlling the input force that a user has to apply to the gear lever 5 in order to select a gear.

[0036] The first shift fork 11a is mounted on the first shift rod 7a and is arranged to actuate a first synchromesh shift collar to selectively engage 1st and 2nd gears. The second shift fork 11b is mounted on the second shift rod 7b and is arranged to actuate a second synchromesh shift collar to selectively engage 3rd and 4th gears. The third shift fork 11c is mounted on the third shift rod 7c and is arranged to actuate a third synchromesh shift collar to selectively engage 5th and 6th gears. The fourth shift fork 11d is mounted on the fourth shift rod 7d, and is arranged to actuate a fourth synchromesh shift collar to selectively engage reverse gear.

[0037] The gear lever 5 is pivotally mounted in a support 4, and is arranged to move in accordance with a conventional slotted "H" type configuration to select 1st to 6th gears and reverse (see Figure 4a). The gear lever 5 is connected to the striking rod 9 via a coupling 15. The coupling 15 rotates the striking rod 9 about the striking rod's longitudinal axis when the user moves the lever 5 within a neutral slot 17 (see Figure 4a) and moves the striking rod 9 axially when the user moves the lever 5 into a gear slot 19a-d.

[0038] The striking rod 9 has drive linkages 21 connected thereto that are arranged to selectively engage the shift rods 7a-d according to the rotational orientation of the striking rod 9 and hence the position of the lever 5.

[0039] Movement of the gear lever 5 within the neutral slot 17 enables the user to select between the first to the fourth shift rods 7a-d by aligning the lever 5 with the associated gear slots 19a-d. For example, when the gear lever 5 is moved within the neutral slot 17 such that it is aligned with the 1st-2nd slot 19a, this causes the striking rod 9 to rotate the drive linkage 21 into driving engagement with the first shift rod 7a. When the user selects first gear by moving the lever 5 along slot 19a, the coupling 15 drives the striking rod 9 in a first axial direction. This causes the drive linkage 21 to drive the first shift rod 7a, the first shift fork 11a and the first synchromesh shift collar to move in the first axial direction until the first shift collar engages 1st gear. When 2nd gear is selected, the coupling 15 drives the striking rod 9 in a second axial direction. This causes the drive linkage 21 to drive the first shift rod 7a, the first shift fork 11a and the first shift collar in the second axial direction, until the first shift collar engages 2nd gear.

[0040] Selection of 3rd and 4th gears is achieved in a similar manner by aligning the gear lever 5 with the 3rd-4th slot 19b. This causes the striking rod 9 to rotate the driving linkage 21 into driving engagement with the second shift rod 7b. Selecting 5th and 6th gears is achieved by aligning the gear lever 5 with the 5th-6th slot 19c. This causes the striking rod 9 to rotate the driving linkage 21 into driving engagement with the third shift rod 7c. Selecting reverse gear is achieved by aligning the gear lever 5 with the reverse slot 19d. This causes the striking rod

9 to rotate the driving linkage 21 into driving engagement with the fourth shift rod 7d.

[0041] Only one of the first to fourth shift rods 7a-d is drivingly engaged by the drive linkage 21 at any one time.

[0042] The drive system 13 includes a motor 23 and an Electronic Control Unit (ECU) 25 for controlling operation of the motor 23. The ECU 25 receives data from: a linear and angular position sensor 27 that monitors the axial position and angular orientation of the striking rod 9; a sensor 29 that is arranged to measure the output of the engine, typically the speed of the engine; a force sensor 31 that is arranged to detect the load applied by the vehicle driver to the striking rod 9 and/or the lever 5; and from at least one other sensor 33 that is arranged to measure a vehicle parameter, such as vehicle speed or temperature, for example engine temperature and/or temperature within a transmission housing.

[0043] The signals from the angular sensor 27 enable the ECU 25 to determine whether or not the gear lever 5 is aligned with one of the gear slots 19a-d.

[0044] The motor 23 is connected to the striking rod 9 such that it can apply a load to the striking rod 9 in at least one axial direction. For example, the motor 23 can comprise a linear motor or the motor 23 can comprise an electric motor that includes a mechanism for converting rotary motion into linear motion, such as a rack and pinion type arrangement. It is preferred that the motor 23 is arranged to load the striking rod 9 in the first and second axial directions.

[0045] When the driver selects a gear, the ECU 25 determines the force applied to the striking rod 9, and hence the force applied to the gear lever 5, by the driver, by taking readings from the force sensor(s) 31. The ECU 25 then estimates the driver desired shift depending on vehicle parameter(s) 33 such as vehicle speed, and/or engine speed; estimates the required effort to reduce or increase the effort to reach the target driver effort; and controls operation of the motor 23 to load the striking rod 9 in the appropriate direction to reach the target driver effort. Thus the motor 23 either provides increased resistance to movement of the striking rod 9 or provides power-assisted movement in the direction of movement of the striking rod 9 according to the control algorithm of the ECU 25. Therefore when the user selects a gear, the "feel" of the shift is controlled by the ECU 25. The linear and angular sensor 27 provides feedback to the ECU 25 regarding the linear position and angular orientation of the striking rod 9.

[0046] Thus, the ECU 25 controls operation of the motor 23 to assist or to damp the movement of the striking rod 9, and thereby to control the feel of the selection of each gear. When the gear lever 5 is not aligned with one of the gear slots 19a-d, the ECU 25 is programmed not to operate the motor 23. This prevents the motor 23 from trying to load the apparatus 3, when it is not possible to select a gear.

[0047] The electronic control unit 25 is programmed to control the output of the motor 23 such that the feel of each gearshift is substantially the same regardless of the gear being selected and the vehicle operating conditions. For example, in manual transmissions in the prior art, the force required to change gear between lower gears can vary from the force required to change gear between higher gears. The ECU 25 is typically arranged to assist or resist the movement of the striking rod 9, and hence the gear lever 5, in order to provide a substantially more consistent feel when selecting any of the gears, regardless of the vehicle engine speed and/or the vehicle speed. Thus, the invention effectively isolates the gearshift feel from the operating conditions of the vehicle, to provide a substantially consistent gearshifting experience for the driver for all gear selections.

[0048] Figures 5 a to 5 c contrast the non-assisted condition with the drive assisted condition. In general, in the non-assisted condition, each gearshift has its own force-displacement characteristic, whereas the assisted condition has a single force-displacement characteristic for each shift. Figures 5a and 5b show the same gearchange action taken at different speeds. Figure 5a shows a slow gearchange requiring less force; while Figure 5b shows a faster change requiring more force. The use of power assistance or resistance allows a consistent "feel" for fast and slow changes, as shown in Figure 5c.

[0049] Figure 5 illustrates that the ECU 25 can be programmed with a plurality of shift modes wherein each shift mode provides a substantially consistent gear shift feel for every gear selection made under that mode. However, each mode provides a slightly different feel by having its own force-displacement characteristic. For example, when in a sports mode, the driver has to apply a greater force to the gear lever 5 in order to select each of the gears. When selecting a comfort mode, the driver has to apply less effort to the gear lever 5 in order to select each gear. The vehicle can include a button, dial or switch to enable the driver to select between the different modes. Alternatively, the driver can select the modes via a computer interface, such as a touch-sensitive screen or a menu driven system.

[0050] It will be apparent to the skilled person that modifications can be made to the above embodiment that fall within the scope of the invention. For example, the dedicated control system can be arranged to receive inputs from an Engine Control Unit, Transmission Control Unit, or any other suitable vehicle system, for example via a vehicle CAN-bus.

[0051] While the invention is described with reference to a six-speed transmission, it will be apparent to the skilled person that the invention is applicable to manual transmissions having any number of gear ratios.

[0052] In the above embodiment, the drive system 13 is arranged to act on the striking rod 9 in order to control the input force that a user has to apply to the gear lever 5 in order to select a gear. However, the drive system 13 can be arranged to act on other parts of the apparatus for selecting a gear 3, such as on each of the shift rods 7a-d. For example, separate motors can be arranged to

act on each of the first to fourth shift rods 7a-d. Additionally, or alternatively, the drive system 13 can be arranged to act on the shift forks 11a-d, the gear lever 5 and/or any other suitable linkage between the gear lever 5 and the shift forks 11a-d.

[0053] Some manual transmissions do not include a striking rod 9 but rather the lower end of the gear lever, or some intermediate linkage, is arranged to selectively engage each of the shift rods to move them according to the operational position of the gear lever. The invention is also applicable to this arrangement of manual transmission, since the drive system can be applied to the shift rods, to the gear lever, or to an intermediate linkage, as mentioned above.

Claims

1. Actuation apparatus (3) for a manual transmission (1), said apparatus including
a manual gearshift mechanism having a manually operable input member (5) arranged to enable a user to make gear selections; and an actuator assembly (13) for communicating an input force applied to the input member (5) to a gear selector device (11a-11d);
drive means (23) arranged to load the manual gearshift mechanism; and control means (25) for controlling operation of the drive means (23), said control means (25) being arranged to control the output of the drive means (23) to control the input force required to operate the input member (5) when a user selects a gear;
wherein the control means (25) is arranged to operate the drive means (23) to provide at least one of power assisted movement to the input member (5) and powered resistance to movement of the input member (5), according to a control algorithm;
characterized in that:

the control means (25) is arranged to control the drive means (23) such that the input force required to operate the input member (5) is substantially the same for each gearshift.

2. Apparatus (3) according to claim 1, including sensing means (27, 29, 31, 33) for sensing at least one of the following parameters: output of the drive means (23); axial position of part (9) of the manual gearshift mechanism; rotational orientation of part (9) of the manual gearshift mechanism; the force applied to the input member (5) and/or actuator assembly (13); temperature; vehicle speed; and the current gear selected; wherein the control means (25) is arranged to control operation of the drive means (23) according to data received from the sensing means (27, 29, 31, 33); and wherein the control means (25) is arranged to estimate the next gear to be selected according to inputs received from the sensing means (27, 29, 31, 33).

3. Apparatus (3) according to claim 1 or claim 2, wherein the control means (25) is arranged to determine the force applied to the input member (5) during a shift; and the control means (25) is also arranged to determine a target force for the user to apply to the input member (5).

4. Apparatus (3) according to claim 3, wherein the control means (25) is arranged to calculate the load to be applied to the gear shift mechanism in order to reach the target force.

5. Apparatus (3) according to claim 4, wherein the control means (25) is arranged to control the output of the drive means (23) to reach the target force.

6. Apparatus (3) according to any one of the preceding claims, wherein the drive means (23) is arranged to load the actuator assembly (13), and the load is communicated to the input member (5) via the actuator assembly (13).

7. Apparatus (3) according to claim 6, wherein the actuator assembly (13) includes at least one actuator member having a longitudinal axis, and the drive means (23) is arranged to load the actuator member to move in at least one axial direction.

8. Apparatus (3) according to any one of the preceding claims, wherein the actuator assembly (13) includes at least one shift rod (7a-7d) having a shift fork (11a-11d) mounted thereon, wherein the shift rod (7a-7d) is operably connected to the input member (5) and is arranged to communicate load between the input member and the gear selector device via the shift fork (11a-11d).

9. Apparatus (3) according to claim 8, wherein the actuator assembly (13) includes a striking rod (9) that is operably connected to the input member (5) and is arranged to communicate load between the input member and the or each shift rod (7a-7d) and/or the or each shift fork (11a-11d) via a linkage.

10. Apparatus (3) according to claim 9, wherein the drive means (23) is positioned to drive at least one of the striking rod (9), shift rods (7a-7d), shift forks (11a-11d) and linkage.

11. Apparatus (3) according to any one of the preceding claims, wherein the drive means (23) is positioned to drive the input member (5).

12. Apparatus (3) according to any one of the preceding claims, including selection means arranged to ena-

ble a user to select from a plurality of shift modes.

13. A method for selecting a gear in a manual transmission (1), said method including:

providing actuation apparatus (3) according to any one of claims 1 to 12 including a manual gearshift mechanism having a manually operable input member (5) for making gear selections, and an actuator assembly (13) for communicating an input force applied to the input member (5) to a gear selector device (11a-11d);
loading the manual gearshift mechanism using drive means (23);
adjusting the output of the drive means (23) to control the input force required to operate the input member (5) when a user selects a gear;
and including controlling the drive means (23) such that the input force required to operate the input member (5) is substantially the same for each gearshift.

14. A method according to claim 13, including estimating the next gear to be selected according to inputs received from sensor means (27, 29, 31, 33).

15. A vehicle including apparatus (3) according to any one of claims 1 to 12 and/or adapted to use a method of claim 13 or claim 14.

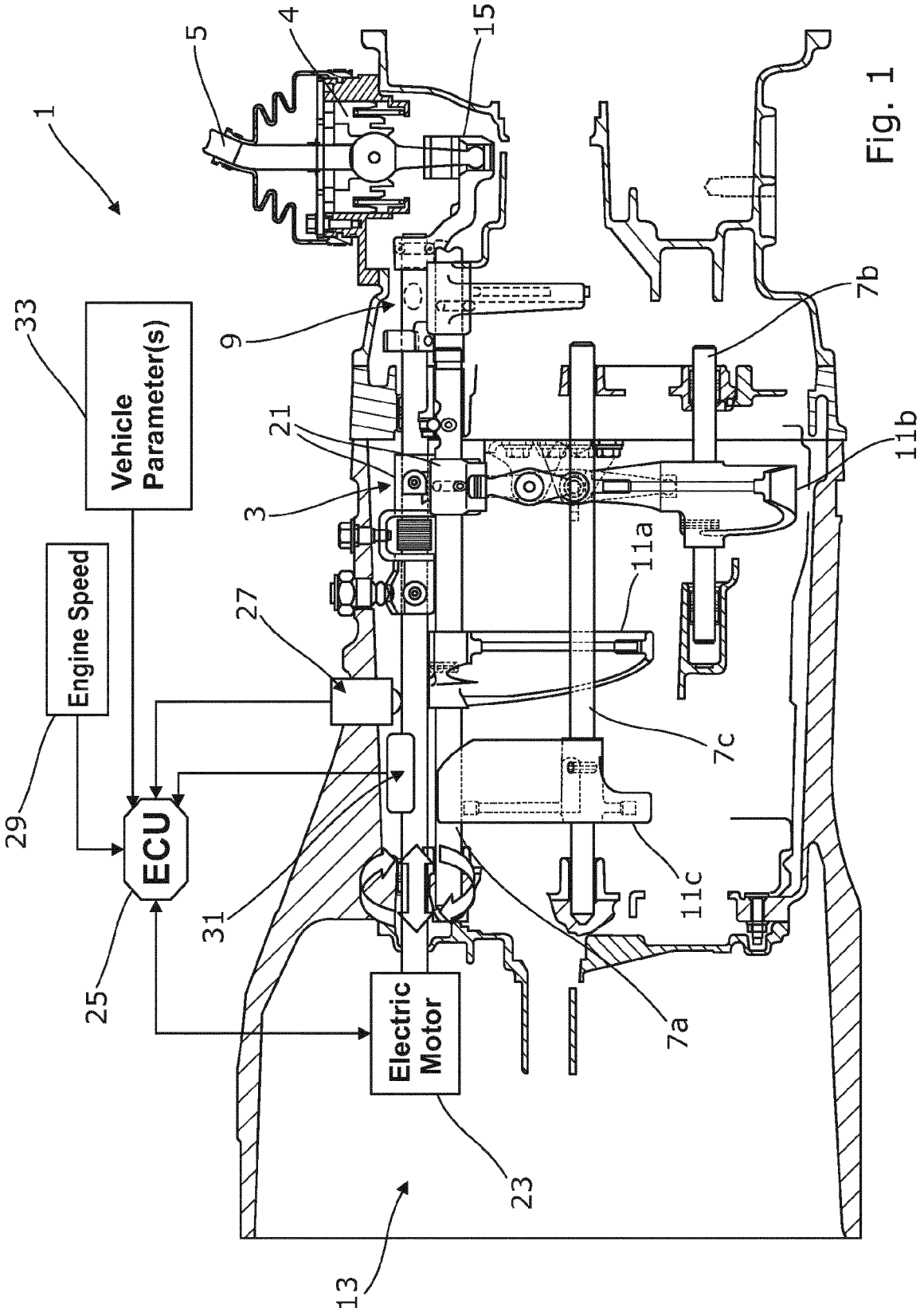
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Fig. 1

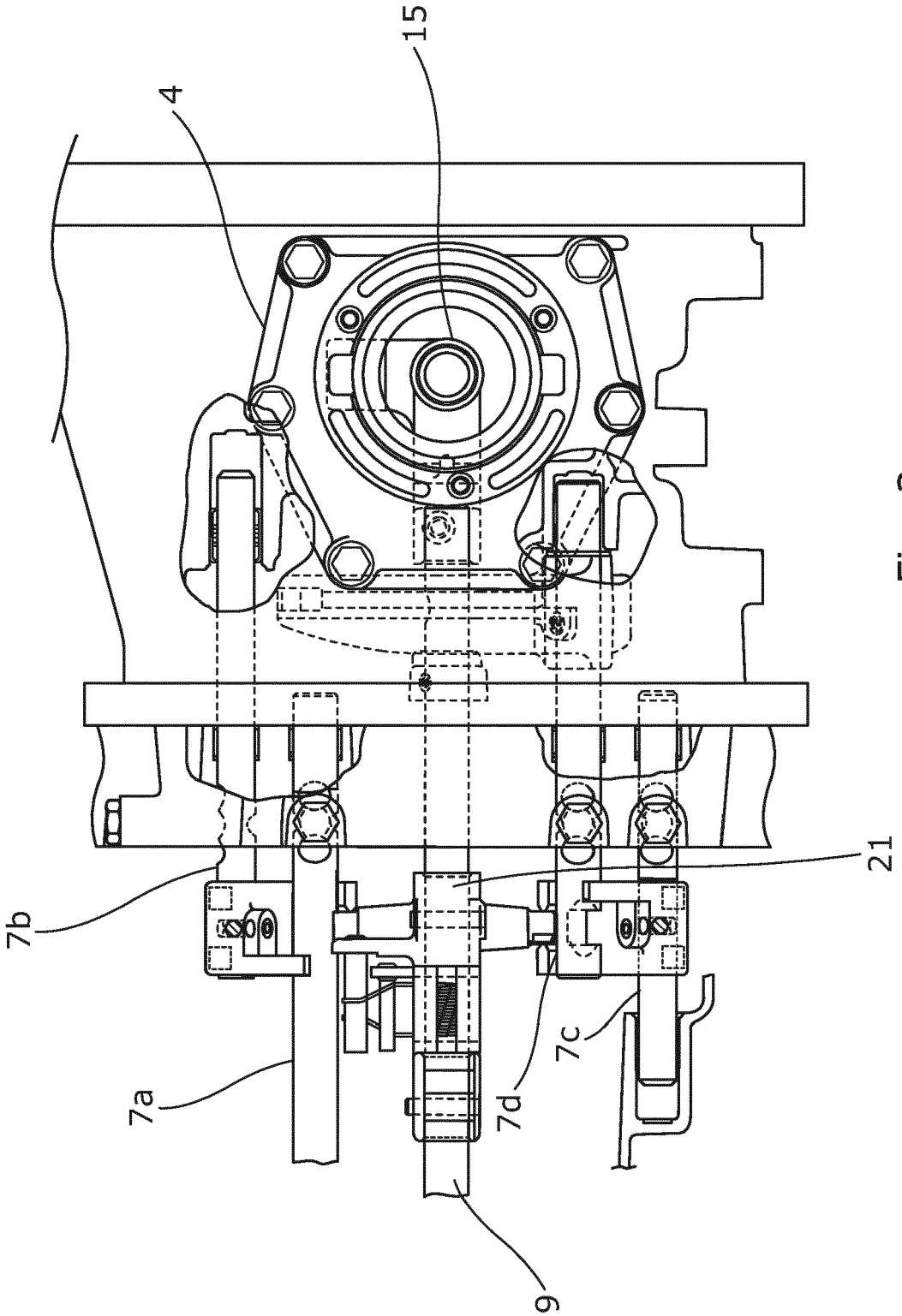

Fig. 2

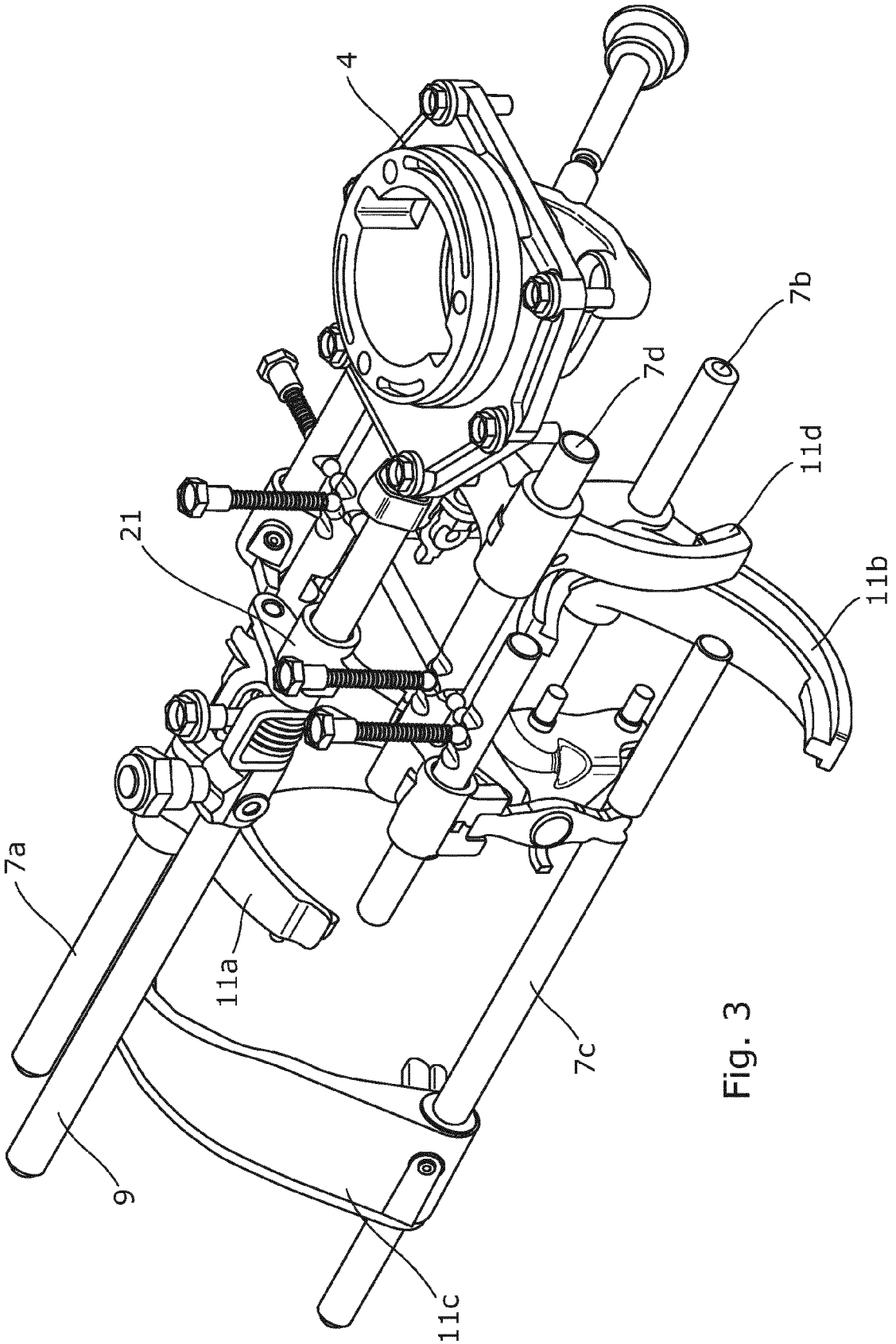

Fig. 3

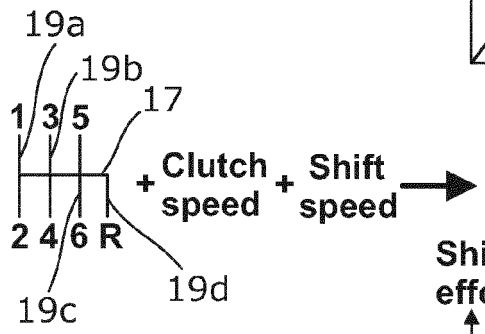

Fig. 4

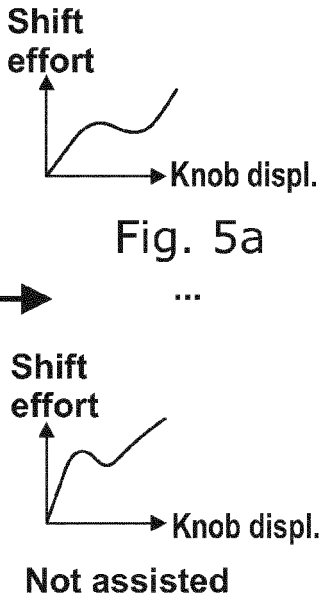

Fig. 5a

Fig. 5b

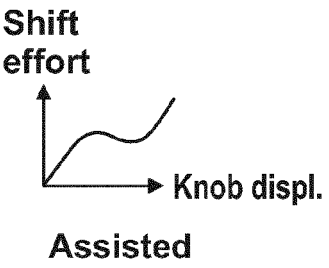

Fig. 5c

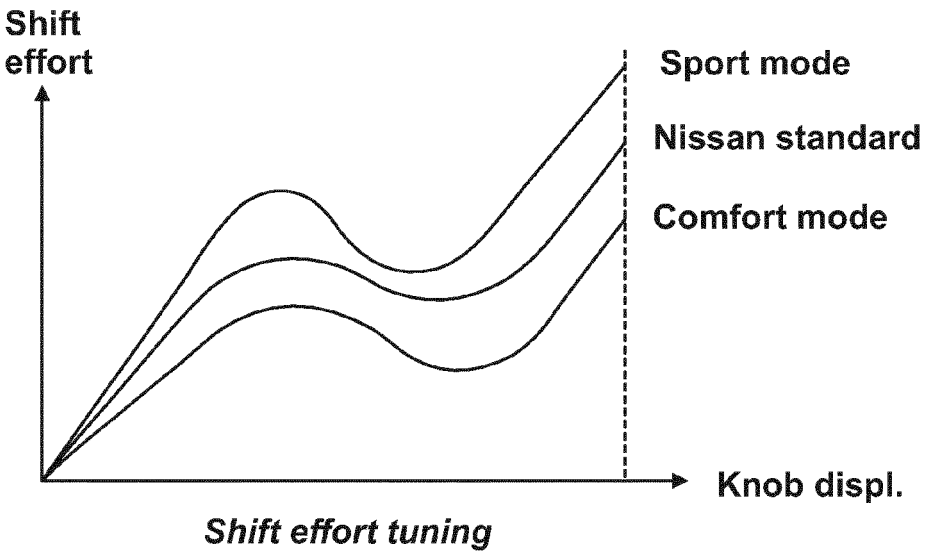

Fig. 6

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 7227

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 855 109 A1 (RENAULT SA [FR]) 26 November 2004 (2004-11-26) * page 1, lines 26-33; figures 1,2a,2b,3,4 * * page 3, lines 25-27 * * page 4, lines 5-9 * * page 7, lines 8-11 * * page 9, lines 18-22 * * page 10, lines 27-32 *	1-3, 11-15	INV. F16H61/32
A	EP 1 167 837 A2 (ISUZU MOTORS LTD [JP]) 2 January 2002 (2002-01-02) * paragraph [0015] - paragraph [0020]; figures 1-6 *	1-15	
A	AT 507 732 A1 (MELECS EWS GMBH & CO KG [AT]) 15 July 2010 (2010-07-15) * page 3; figures 2,4 *	1-15	
A	DE 195 39 472 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 30 April 1997 (1997-04-30) * column 1, lines 56-59 * * column 2, lines 43-52 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F16H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 July 2012	Bourgoin, J

CATEGORY OF CITED DOCUMENTS

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